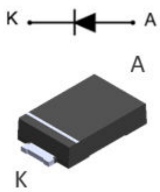
650 V, 4 A high surge silicon carbide power Schottky diode



SMB Flat

Product label
SUSTAINABLE TECHNOLOGY

Product status link
STPSC4G065UF

Product summary	
$I_{F(AV)}$	4 A
V_{RRM}	650 V
T_j(max.)	175 °C
V_F(typ.)	1.30 V

Features

- None or negligible reverse recovery charge in application current range
- Switching behaviour independent of temperature
- High forward surge capability
- Operating T_j from -55 °C to +175 °C
- ECOPACK2 compliant component

Application

- SMPS in telecom power
- Datacenter
- Industrial equipment
- Solar converter
- Air conditioning equipment

Description

The SiC diode, available in SMB-Flat, is an ultrahigh performance power Schottky rectifier. It is manufactured using a silicon carbide substrate. The wide band-gap material allows the design of a low V_F Schottky diode structure with a 650 V rating. Thanks to the Schottky construction, no recovery is shown at turn-off and ringing patterns are negligible. The minimal capacitive turn-off behavior is independent of temperature.

Based on technology optimization, this diode has an improved forward surge current capability, making it ideal for use in PFC, where this ST SiC diode boosts the performance in hard switching conditions while bringing robustness to the design. Its high forward surge capability ensures a good robustness during transient phases.

1 Characteristics

Table 1. **Absolute ratings (limiting values at 25 °C, unless otherwise specified)**

Symbol	Parameter			Value	Unit
V_{RRM}	Repetitive peak reverse voltage			650	V
$I_{F(RMS)}$	Forward rms current			10	A
$I_{F(AV)}$	Average forward current	T_l = 70 °C, T_j = 175 °C, δ = 1		4	A
I_{FRM}	Repetitive peak forward current	T_l = 70 °C, T_j = 175 °C, δ = 0.1, f_{sw} > 10 kHz		16	A
I_{FSM}	Surge non repetitive forward current	t_p = 10 ms sinusoidal	T_c = 25 °C	30	A
			T_c = 150 °C	27	
		t_p = 10 µs square	T_c = 25 °C	400	
T_{stg}	Storage temperature range			-65 to +175	°C
T_j	Operating junction temperature range			-55 to +175	°C

Table 2. **Thermal resistance parameters**

Symbol	Parameter	Value		Unit
		Typ.	Max.	
$R_{th(j-l)}$	Junction to lead	10.5	15	°C/W

For more information, you can refer to the following application note:

- AN5088 : Rectifiers thermal management, handling and mounting recommendations

Table 3. **Static electrical characteristics**

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
I_R (1)	Reverse leakage current	T_j = 25 °C	$V_R = V_{RRM}$	-	4	40	µA
		T_j = 175 °C		-	23	170	
V_F (2)	Forward voltage drop	T_j = 25 °C	I_F = 4 A	-	1.3	1.45	V
		T_j = 175 °C		-	1.49	1.70	

1. *Pulse test: t_p = 10 ms, δ < 2%*
2. *Pulse test: t_p = 380 µs, δ < 2%*

To evaluate the conduction losses, use the following equation:

$P = 0.879 \times I_{F(AV)} + 0.206 \times I_F{}^2{}_{(RMS)}$

For more information, you can refer to the following application notes related to the power losses:

- AN604: Calculation of conduction losses in a power rectifier
- AN4021: Calculation of reverse losses on a power diode

Table 4. **Dynamic electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Q_{Cj} (1)	Total capacitive charge	V_R = 400 V	-	14.5	-	nC
C_j	Total capacitance	V_R = 0 V, T_c = 25 °C, F = 1 MHz	-	285	-	pF
		V_R = 400 V, T_c = 25 °C, F = 1 MHz	-	20	-	

1. *Most accurate value for the capacitive charge:* $Q_{cj}(V_R) = \int_0^{V_R} C_j(V)dV$

Figure 1. **Thermal transient impedance model circuit of the diode – $Z_{th(j-l)}$**

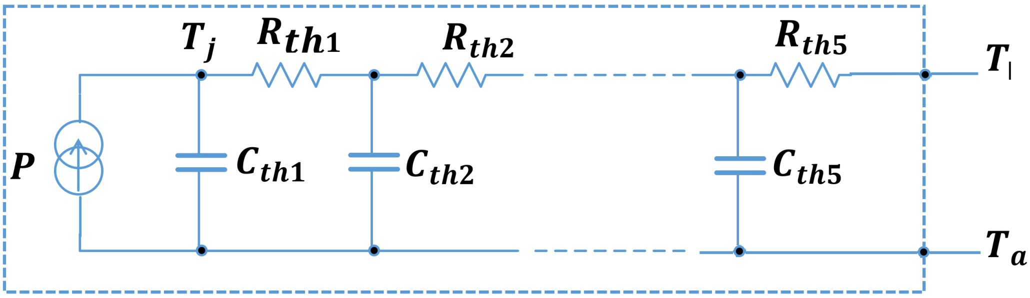


Table 5. **Components typical values of the diode thermal transient impedance model $Z_{th(j-l)}$**

Ref.	Value (K/W)	Ref.	Value (J/K)
R_{th1}	606.69 m	C_{th1}	0.45 m
R_{th2}	1442.64 m	C_{th2}	1.67 m
R_{th3}	5125.21 m	C_{th3}	6.15 m
R_{th4}	2580.19 m	C_{th4}	42.94 m
R_{th5}	701.27 m	C_{th5}	928.09 m

1.1 Characteristics (curves)

Figure 2. Forward voltage drop versus forward current (typical values)

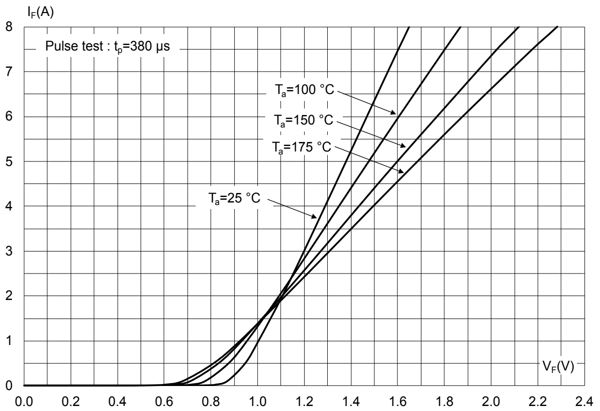


Figure 3. Reverse leakage current versus reverse voltage applied (typical values)

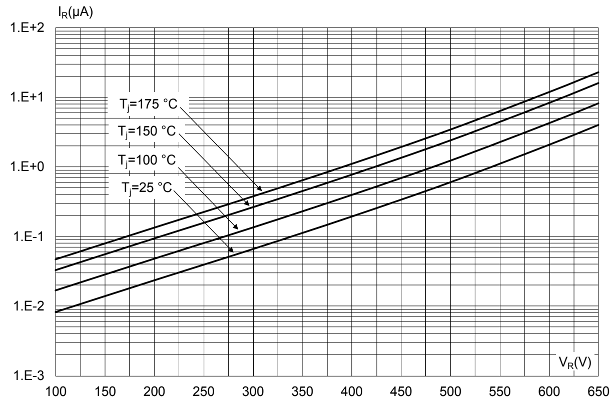


Figure 4. Peak forward current versus lead temperature (f_{sw} > 10 kHz)

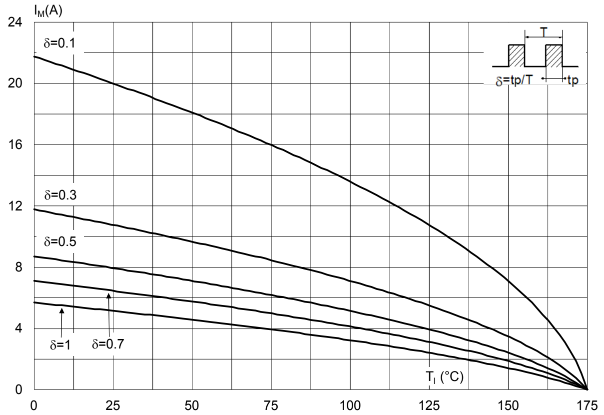


Figure 5. Junction capacitance versus reverse voltage applied (typical values)

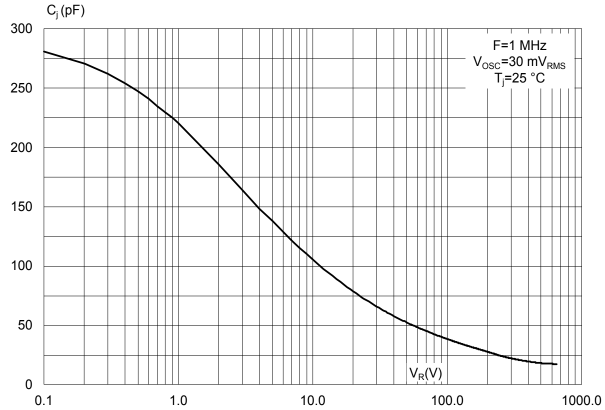


Figure 6. Relative variation of thermal impedance junction to lead versus pulse duration

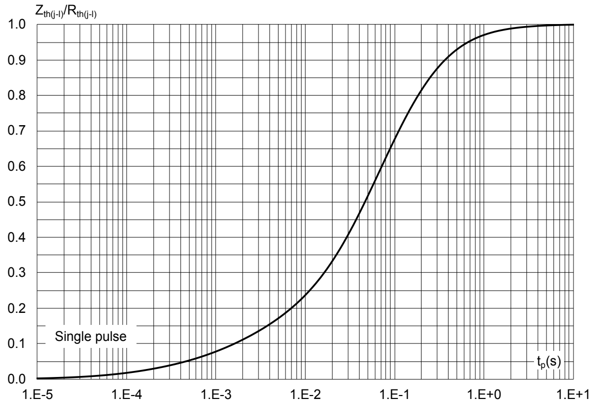


Figure 7. Non-repetitive peak surge forward current versus pulse duration (sinusoidal waveform)

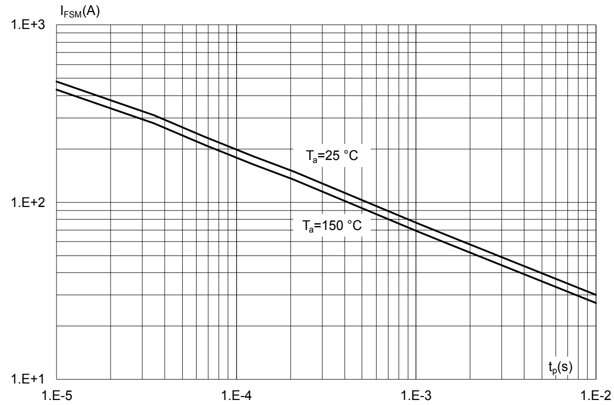


Figure 8. Total capacitive charges versus reverse voltage applied (typical values)

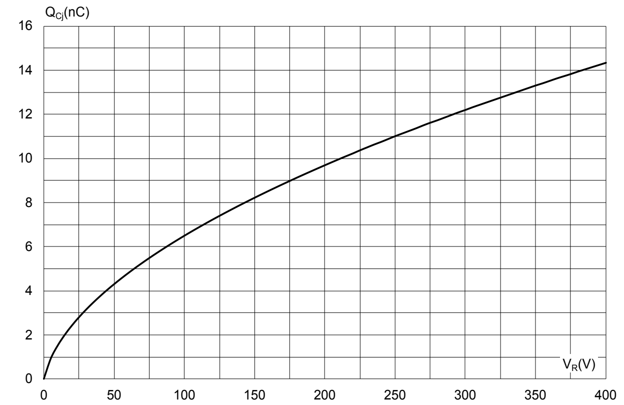
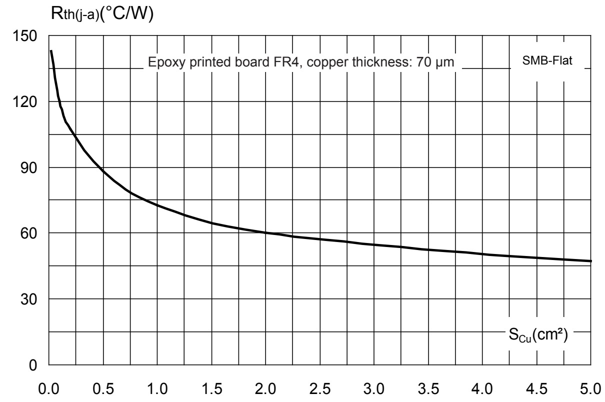


Figure 9. Thermal resistance junction to ambient versus copper surface under each lead (typical values)



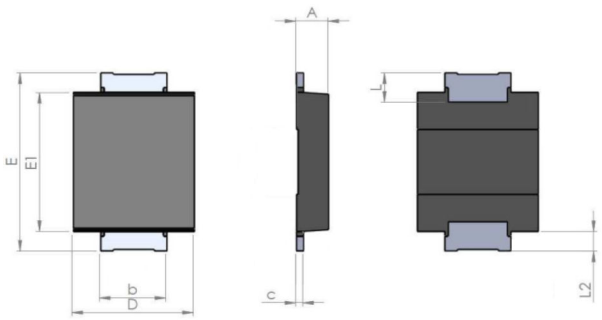
2 Package information

To meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions, and product status are available at: www.st.com. ECOPACK is an ST trademark.

2.1 SMB Flat package information

- Epoxy meets UL94, V0
- Lead-free package

Figure 10. SMB Flat package outline

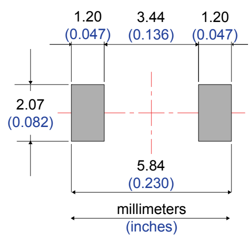


Note: Note: This package drawing may slightly differ from the physical package. However, all the specified dimensions are guaranteed.

Table 6. SMB Flat mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.10	0.035		0.043
b	1.95		2.20	0.077		0.087
c	0.15		0.40	0.006		0.016
D	3.30		3.95	0.130		0.156
E	5.10		5.60	0.200		0.220
E1	4.05		4.60	0.159		0.181
L	0.75		1.50	0.030		0.060
L2		0.60			0.024	

Figure 11. Footprint recommendations, dimensions in mm (inches)



3 Ordering information

Table 7. **Ordering information**

Order code	Marking	Package	Weight	Base qty.	Delivery mode
STPSC4G065UF	4G65	SMB Flat	0.050 g	5000	Tape and reel

Revision history

Table 8. **Document revision history**

Date	Revision	Changes
11-Feb-2025	1	Initial release.